

How Elastic is China's Export When Facing Exchange Rate Changes

*An empirical analysis of China's export
exchange rate elasticity*

Leiming Hong



Master of Philosophy in Environmental and
Development Economics
Department of Economics
UNIVERSITY OF OSLO

SUBMITTED: MAY, 2012

PREFACE

The master thesis implies that my two years' study at University of Oslo is approaching the end. The two year program of Master of Philosophy in Environmental and Development Economics at University of Oslo has left me so many wonderful memories I will treasure for my whole life.

Firstly, I would like to thank my thesis supervisor Professor Asbjørn Rødseth. He has offered so many insightful and valuable instructions to me about the thesis and spent a lot of time discussing with me about the problems I encountered. Without his help, it would be impossible for me to finish this thesis. Besides the thesis, I also took Macroeconomic Theory and International Macroeconomics given by Professor Rødseth. His lectures and ideas have greatly expanded my horizon and deepened my understanding about economics. Secondly, I would like to thank Michele and Lynn from International Education Office at University of Oslo. Their help is crucial for me to successfully complete my study in Norway. Thirdly, I would also like to thank all the professors and teachers who gave the lectures and seminars to me and the administrative staff in the university who helped me out of various issues. They have made my study in Norway a wonderful, fruitful and unforgettable experience. Fourthly, I would like to thank the Norwegian Education Loan Fund for providing the generous Quota Scheme funding for my study in Norway. The scholarship allowed me to put more emphasis on studying and I did learn a lot during my stay in Norway. I would also like to thank my parents. Their supports are always important for me during my study away from China. Last but not least, I would also like to thank all my friends whom I knew during my stay in Norway. Now, I am so lucky to have friends in many countries around Europe and the friendship is what I will treasure forever.

Norway is really a nice country with its nice people and beautiful sceneries. I will always treasure the time in the little but beautiful, nice and dynamic country.

SUMMARY

The past three decades has witnessed a dramatic development of China's exports. Now, China is one of the largest and most important players in international trade while thirty years ago, it was one of the poorest countries in the world with barely few trade connections with the rest of the world. Joining the World Trade Organization greatly deepened China's integration to the international market and China successfully grasped the opportunity and made a great leap in the development of its exports. Both the value and the structure of China's exports have changed dramatically since China joined WTO.

Though China has made great achievements in its exports, it is criticized by many developed economies such as the U.S. and the EU that many of the achievements were made through manipulating the exchange rate which helped to keep the RMB undervalued. These critics started a hot debate about the RMB exchange rate.

One of the key focuses in the debate is how large the shock brought by the change of exchange rate will be and the best way to gauge it is to estimate the export exchange rate elasticity. Many researchers have studied China's export exchange elasticity at the aggregate level, however, the structure of China's exports have changed dramatically and any research which neglected this dramatic structural change may finally result in misleading conclusions. To grasp the dramatic structural change of China's export, this paper classified China's manufactured exports into capital and technology intensive products and labor intensive products. By decomposing the export exchange rate elasticity into export price elasticity and exchange rate pass through and using the ARDL method for co-integration, this paper estimated China's export exchange rate elasticity of both capital and technology intensive products and labor intensive products. The empirical analysis¹ found that the export exchange rate elasticity is much smaller for capital and technology intensive products and the difference mainly came from the difference in export price elasticity while the exchange rate pass through for both of the groups were close.

¹ The calculation was based on Microfit 4.1, which is a software developed for the ARDL method for co-integration.

Contents

Chapter 1 Introduction	1
Chapter 2 China's foreign trade: past, present and the future	2
2.1 China's foreign trade and exchange rate	2
2.2 The change of China's export structure.....	7
2.2.1 The change of trade partners	8
2.2.2 The change of export product structure.....	8
Chapter 3 Literature review.....	12
3.1 Worldwide trade elasticity studies.....	12
3.2 China's trade elasticity studies	14
Chapter 4 Estimating export exchange rate elasticity based on trade volume data	16
4.1 The export price elasticity	17
4.1.1 The data and econometric model.....	17
4.1.2 Estimation of econometric model	21
4.2 The export exchange rate elasticity	29
4.3. Estimations on the SITC one digit level.....	36
4.4 Sum up.....	39
Chapter 5 Conclusions and the policy related issues	39
Reference.....	42
Annex1: The calculation of the variables in the econometric model	46
Annex 2: A brief introduction of AIC, SBC and HQ	48

Chapter 1 Introduction

China has enjoyed an incredibly fast growth for over three decades since its opening up and reform. Thirty years ago, China was among the poorest countries in the world with very few connections towards the rest of the world, and now, China is the world's second largest economy. China's opening up and reform has dramatically deepened its integration into the world market and made international trade an important source of China's growth. For the past thirty years, China's international trade has grown dramatically. Not only the low technology products, more and more Chinese products with relatively high technology and sophistication appear in the world market and China has earned a name of "the World's factory".

Joining the World Trade Organization in 2001 provided China a great opportunity to deepen its integration into the world market and China has successfully expanded its trade dramatically with the rest of the world. Since the two parallel exchange rate systems were unified in 1994, China had pegged RMB exchange rate with USD for long. The stable exchange rate provided a stable international trade environment for the export sector, allowing them to have a rather stable expectation about their export incomes, and became one of the key factors for the success in foreign trade. However, this exchange rate policy was also criticized by the U.S. and the European Union as they believed the Chinese government manipulated the RMB exchange rate to maintain the price advantages for Chinese products and this is the key reason for the huge imbalance of the international trade.

China's central bank started the reform of exchange rate policy in 2005 and the world has witnessed the appreciation of the RMB since then. Due to the important role foreign trade has played in China's economic growth, the shock brought by the change of exchange rate towards the foreign trade became the focus in both political and economic field. When evaluating the shocks brought by the change of exchange rate towards the foreign trade, the estimation of exchange rate elasticity is always the key. This paper will focus on China's export and try to estimate China's export exchange rate elasticity so as to measure the shock

of the change of exchange rate. Many researchers have studied China's export exchange rate elasticity at the aggregate level, however, China's fast growth has dramatically changed the structure of China's exports and any research which neglects this dramatic structural change may finally result in misleading conclusions. The intension of this paper is try to estimate China's export exchange rate elasticity based on the dramatic change of China's exports and try to offer valuable policy recommendations based on the estimation.

The structure of the paper is as follows: Chapter 2 will generally describe the history of China's international trade and China's exchange rate policy reform. Based on data and various researches, it will also present the dramatic structural change of China's exports. Chapter 3 will generally review the related literatures and Chapter 4 will estimate China's export exchange rate by using a newly appeared method for co-integration. Chapter 5 will conclude and relate the conclusion to policy issues.

Chapter 2 China's foreign trade: past, present and the future

2.1 China's foreign trade and exchange rate

According to the famous macroeconomic equation, consumptions, investments and exports are the three main sources for the growth of a nation's economy. China used to take the "counter-comparative advantage" strategy for three decades before the reform and opening up and focused on developing the heavy industries. In order to provide the capital accumulation for developing the heavy industries, consumptions were strictly limited through China's central planning economic orders and at the same time, the strict regulations established for international communication also limited China's foreign trade with the rest of the world and the amount of the foreign trade only accounted for 10% of the nation's GDP. It is very clear that, for the three decades before China's reform, investments were the major source of China's economic growth.

The three decades after China's reform and opening up has witnessed its continuous

integration into the global economy. Following Japan and the “Asian Tigers”², which took exports as a major source of economic growth, China switched its economic policy which enabled it to use the comparative advantage and this has made great impacts on the global economy. Due to the badly-functioning social welfare system and the culture with long history which values saving, the power consumptions have put on the growth of the economy is still quite limited, but since the regulations that restrict the foreign communication and the restriction on migration started to get loosen, China started to provide huge labor resources to the world market and export became another strong turbo for the growth of the economy. Within two decades from 1980 when China started its reform and opening up, China’s total export soared from USD 20.02 billion towards USD 225.09 billion and since 1990, China started to accumulate its trade surplus and it grew from USD 8.7 billion in 1990 to USD 24.11 billion in 2000.

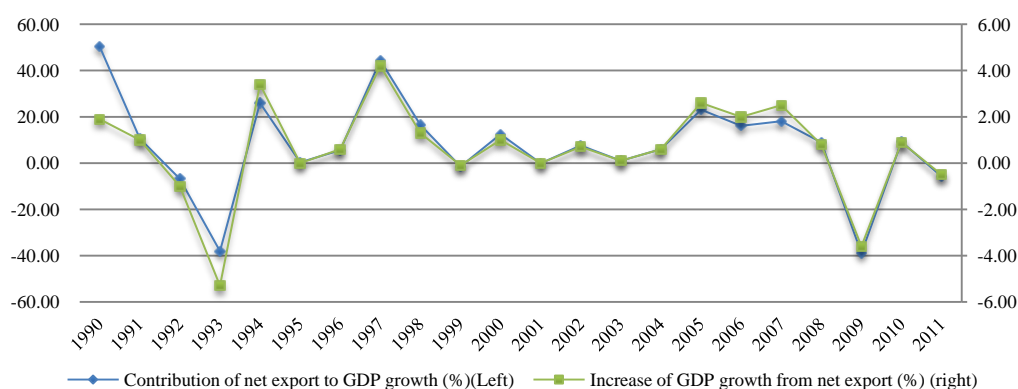
China’s entrance towards the World Trade Organization (WTO) in November 2001 greatly deepened China’s integration into the world market. China had huge advantage in producing labor intensive products due to the massive labor resource supply, low wage and low life standards and many regional labor intensive products providers (i.e. Mexico in North America and Portugal in the Europe) got substituted when China joined the WTO. Also, since its entrance towards the WTO, China has made great leaps on the foreign trade. In 2002 when China just joined the organization, the export amounted to USD 325.6 billion while in 2008 right before the global financial crisis it soared to USD 1430.69 billion which was four times as that in 2002 and even during the financial crisis in 2009, it still amounted to USD 1201.61 billion. The value of export continued breaking the records in 2010 and 2011 when the global economy stabilized after the crisis (USD 1577.75 billion in 2010 and USD 1898.6 billion in 2011).³ At the same time, the trade surplus also soared from USD 30.43 billion in 2002 to USD 298.12 billion in 2008. Exhibit 1 illustrates the contribution of net export towards the economic growth. The net export contributed 23.1%, 16.1%, 18.1% and 9% of the economic growth and correspondingly increased the GDP growth rate by 2.6%, 2.0% and 2.5% and 0.8%

² Namely South Korea, Taiwan, Hong Kong and Singapore

³ All figures are in current USD

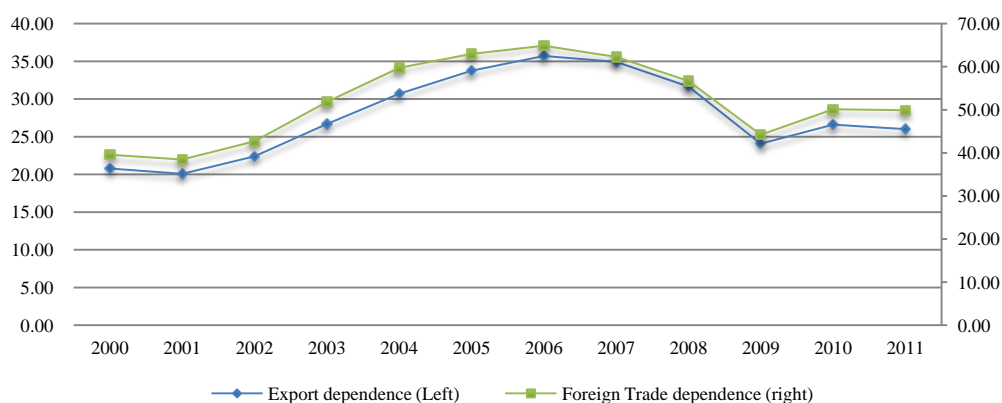
from 2005 to 2008 respectively. China's dependence on foreign trade also grew substantially after joining the WTO. In 2000 and 2001 before joining the WTO, China's export dependence and foreign trade dependence⁴ was around 20% and 40%, but it soared to 35.72% and 64.87% in 2006 which made China the most trade dependent country among the world's major powers. Since 2008, because of the financial crisis and Europe debt crisis, the contribution of trade towards economic growth has decreased somehow, but no matter from the perspectives of trade amount or trade dependence, foreign trade still plays an essential role in Chinese economy.

Exhibit 1 Contribution of foreign trade to GDP growth



For example, in 2006, net export contributed 16% of the GDP growth and increased the GDP growth rate for 2%.

Exhibit 2 China's export and trade dependence

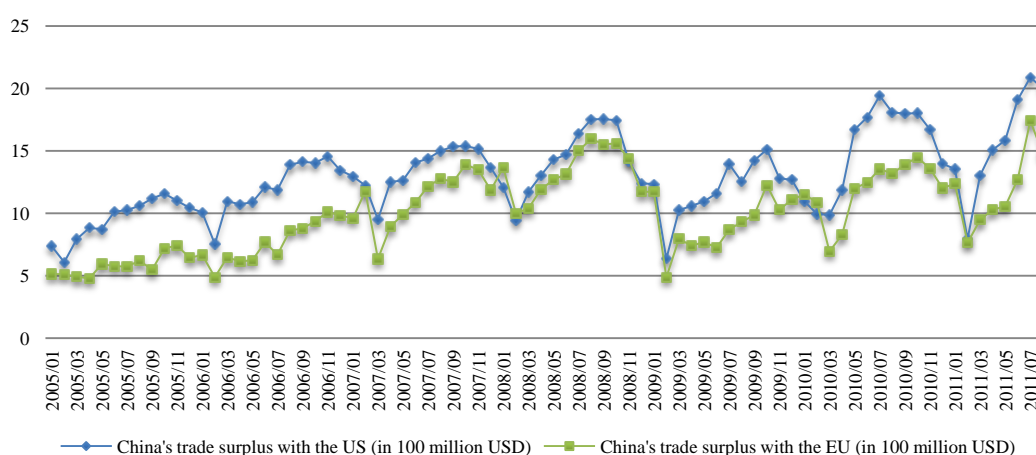


China has accumulated huge amount of foreign currency reserve due to the fast development

⁴ Export dependence is defined as the value of export divided by GDP. Foreign trade dependence is defined as the value of export and import divided by GDP.

of the foreign trade and the soaring trade surplus. According to the statistics of China's State Authority of Foreign Exchange (SAFE), China's foreign currency reserve was USD 212.17 billion in 2001 and by the end of 2011, it has reached USD 3181.15 billion, which is around 15 times of that in 2001. While China is accumulating its foreign currency reserve from the huge trade surplus, its two largest trade partners namely the U.S. and the EU have experienced huge trade deficit and RMB, China's currency, was criticized to be responsible for that.

Exhibit 3 China's Trade Surplus with the U.S. and the EU



The exchange rate reform in 1994 ended China's two exchange rates system since 1980⁵. When the official exchange rate and that in the market merged together, the exchange rate quickly moved towards the market one and since then, Chinese government pegged the exchange rate with the US dollar for a long time. The exchange rate of RMB was 8.62 RMB per 1 USD in 1994. It appreciated slightly to 8.28 RMB per 1 USD in 1998 and remained on that position for a long period. The U.S. and the EU believed that Chinese government supported the nation's export through manipulating the exchange rate. This enabled China to harvest huge trade surplus and also made a lot of manufacturing jobs move from the U.S and the EU towards China. Goldstein (2004) showed that because of the control of exchange rate, the RMB was undervalued from 15% to 25% and this was against the IMF rules. Goldstein also made the following suggestion: 1) Peg RMB with a basket of foreign currencies rather

⁵ From 1980 to 1994, China had two exchange rates, an official exchange and an exchange rate in the market.

than only with the USD, let RMB appreciate 15% to 25% immediately and allow the exchange rate to float in a wider range. 2) Open the capital account and switch to “managed floating exchange rate system” after Chinese banking system become stronger. Cline (2007), Goldstein *et al* (2007) and Stolper *et al* (2007) also used real effective exchange rate or RMB bilateral exchange rate to evaluate whether RMB was undervalued. All the researches above concluded that RMB was undervalued and the range of undervaluation was from 8% to 60% (real effective exchange rate) and from 7% to 40% (RMB bilateral exchange rate). However the results varied when different models and data were used in the estimation and many Chinese researchers found that the range of the RMB undervaluation is much smaller (from 4% to 10%).

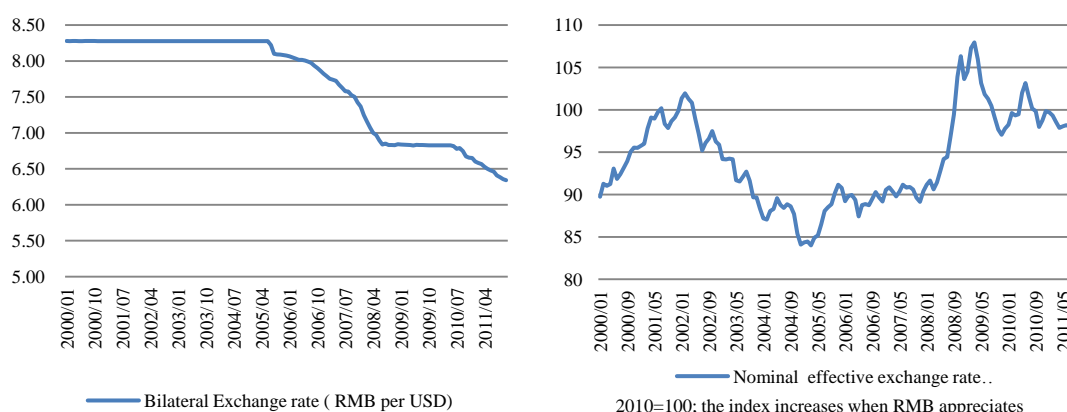
The critics from the U.S. and the EU about the RMB exchange rate made it a hot issue in the international community and there have been many debates about whether the Chinese government should appreciate the RMB, how much should the RMB appreciate and how fast it should appreciate. For those who support that the RMB should appreciate, they believe the sustaining trade surplus and China’s special exchange rate policy⁶ forced the central bank to continuously inject money into the domestic market and that would result in too much liquidity in the market and hence increase the risk of high inflation. But for those who were against the RMB appreciation, they used the long term stagnation of Japanese economy as an example of the result of currency appreciation and they also claim that the RMB appreciation would greatly and negatively shock China’s export and hence slow down the growth of the economy.

On July 21st 2005, People’s Bank of China, China’s central bank started the reform of the RMB exchange rate. This reform includes the following content: First, the RMB would peg towards a basket of currencies rather than the USD; Second, the bilateral exchange rate of the RMB would switch from 8.28 RMB per USD to 8.11 RMB per USD, which meant an immediate appreciation of 2%; Third, the bilateral exchange rate between the RMB and USD would continue to float within the range of 0.3% in every trading day. The actions taken by

⁶ The inflow of foreign currency became one of the major reasons for the money growth in China.

Chinese central bank were kind of similar with the suggestions made by Goldstein (2004). Since then the RMB started its long term continuous appreciation. The appreciation was ceased from 2009 to mid 2010 in the terms of the RMB and USD bilateral term because of the global financial crisis, but it was resumed after June 2010 when Chinese central bank claimed to continue the reform of the RMB exchange rate. Exhibit 4 illustrates the change of the RMB and USD bilateral exchange rate and the RMB nominal effective exchange rate. From July 2005 to November 2011, the RMB and USD bilateral exchange rate appreciated for 23% and the RMB nominal effective exchange rate appreciated for 20.2%.

Exhibit 4 RMB bilateral exchange rate and RMB real effective exchange rate



Even though the RMB significantly appreciated, China's trade surplus continued widening, which went against people's expectation. From 2005 to 2008, China's foreign trade and trade surplus soared when the RMB appreciated significantly at the same time. In 2010, when the RMB resumed its appreciation and the economy stabilized as the world's major governments saved the markets collectively, the foreign trade and trade surplus soared again.

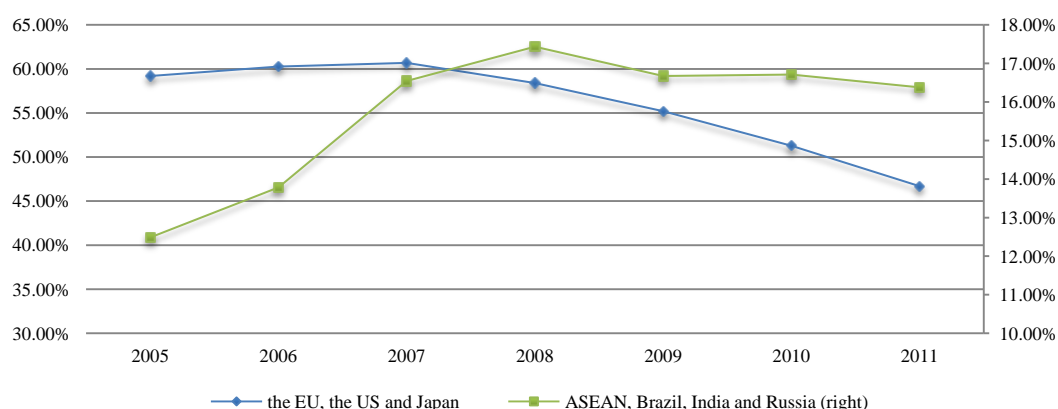
2.2 The change of China's export structure

International economic theory clearly cannot explain the change of foreign trade data on the aggregate level and the exchange rate and this requires a deeper analysis of China's foreign trade. Actually, the structure of China's foreign trade has experienced significant changes and this may offer a better explanation for the changes of foreign trade in the past decade.

2.2.1 The change of trade partners

The first structural change about China's exports is about China's trade partners. For a quite long time, an extraordinary large proportion of China's exports depended on the developed markets such as the EU, the U.S. and Japan. Due to the rise of the emerging markets and the exploration of China's exporters, China's export markets have been greatly diversified. I used the percentage of exports towards the U.S., the EU and Japan as the proxy of the exports towards the developed market and the percentage of exports towards the ASEAN countries, Brazil, India and Russia as the proxy of the exports towards the emerging markets. Exhibit 5 illustrates the change of the percentages of exports towards developed markets and emerging markets. It is quite obvious that from 2005 to 2011, the proportion of exports towards developed markets went up and down. In 2007, the percentage of exports towards the EU, the U.S., and Japan accounted for 60% of China's total exports while in 2011, the percentage was 46.69%. However, there is an increasing trend of the exports towards the emerging markets. The percentage of exports towards the ASEAN countries, Brazil, India and Russia increased from 12.5% in 2005 to around 16% and 17% in 2011.

Exhibit 5 The changing percentage of exports towards developed and emerging markets



2.2.2 The change of export product structure

The famous international economist Maurice Obstfeld once mentioned that the impacts of exchange rate on the trade of different products varies significantly, so it is necessary to

observe the change of export product structure when we examine the impacts of exchange rate on the foreign trade.

Just as is mentioned above, since the reform and the opening up, China followed the strategy to exploit its comparative advantage, which was its massive labor resource, and started from the labor intensive products. In 1980 when the reform just started, primary goods were still China's main export products which accounted for 50.3% of total exports. When the time reached 1988, the value of industrial products accounted for 69.6% of all exports and that was twice as much as that of the primary goods. In 2011, the percentage of primary products in the exports has decreased to only around 5%. As a country with low natural resource on the per capita level, it is with extremely high probability that the percentage of primary products would continue to decrease and that is why we will focus on the industrial products.

On the issues of the structure of industrial products exports, I would focus on the sophistication classification of the industrial products. There are two main methods to classify the sophistication of industrial products: one method is to classify the products according to Standard International Trade Classification (SITC) and Harmonized Commodity Description and Coding System (HS). The products are classified into different groups according to their SITC or HS codes. The other method is to classify different products according to certain index.

There are mainly two ways to classify different industrial products for the first method of classification. The first is to classify the industrial products into labor intensive and capital and technology intensive products according to SITC one-digit level. The frequency and the richness of the data on SITC one-digit level make it a quite popular way to investigate different industrial products exports in China. According to SITC codes, products that are grouped under SITC5 and SITC7 are considered capital and technology intensive products and those grouped under SITC6 and SITC8 are considered labor intensive products. Fu *et al* (2006), Zeng *et al* (2007), Ma *et al* (2010) used this way to classify the industrial products and capital and technology intensive products are of higher sophistication. Another way is

developed by Lall (2000) based on OECD using SITC 3-digit level group. Lall (2000) classified industrial products into three groups: the low tech group, the mid tech group and the high tech group. The low tech group consists with only SITC6 and SITC8 products and the mid and high tech group consist with products of SITC5 and SITC7 with few SITC6 and SITC8 products. Table 1 displays the percentage of SITC one digit level products in the total industrial products exports (in value terms) from 2000 to 2011. As is seen in table 1, the structure of industrial products exports changed dramatically from 2000 to 2011. From 2000 to 2002, the percentage of labor intensive products which consists of SITC6 and SITC8 products was still higher than that of capital and technology intensive products which consists of SITC5 and SITC7 products. Since then, the percentage of capital and technology intensive products overcame that of labor intensive ones and the difference between the two groups had an increasing trend. The change was mainly due to the increasing percentage of SITC7 machinery and transport equipment and the decreasing percentage of SITC8 miscellaneous manufactured articles. Table 2 displays the percentage of low tech, mid tech and high tech groups from 2005 to 2011. As the sample period is quite short, the change of different products was not significant. But the percentage of low and high tech products decreased while that of mid tech products increased.

Table 1 The composition of exports: Percentage of total industrial product exports

	SITC5	SITC7	SITC6	SITC8
2000	5.4	36.9	19.0	38.6
2001	5.6	39.6	18.3	36.3
2002	5.2	42.7	17.8	34.1
2003	4.9	46.6	17.1	31.3
2004	4.8	48.5	18.2	28.3
2005	5.0	49.4	18.1	27.2
2006	4.9	49.8	19.1	26.0
2007	5.2	49.9	19.0	25.7
2008	5.9	49.9	19.4	24.8
2009	5.5	51.9	16.2	26.3
2010	5.9	52.3	16.7	25.2
2011	6.5	50.0	17.8	25.6

Table 2 The percentages of low, mid and high tech products of total industrial product exports

	Low tech	Mid tech	High tech
--	----------	----------	-----------

2005	36.5	22.7	40.8
2006	36.6	22.4	41.0
2007	36.5	24.5	39.0
2008	36.5	25.8	37.7
2009	35.0	25.1	39.9
2010	34.3	26.0	40.2
2011	35.9	26.6	37.6

The other method is to give sophistication index to different products under more detailed SITC or HS classification and use the index to represent the sophistication of the products. The basic idea of the index is that the products are more sophisticated if these products are produced in richer countries more. Kwan (2002) calculated the sophistication index by a weighted sum of GDP per capita of the countries that export the product and the weight is the percentage of the production of the products the certain country produced of all the production around the world. Fan *et al* (2006) developed this idea by introducing the concept of comparative advantage. Lall *et al* (2006), Rodrik (2006) and Du *et al* (2007) also calculated different index according to the idea. All kinds of index agreed to use a weighted sum of GDP per capita but the main debate was whether the percentage of the product export of all the product export around world or the percentage of the product production of all the production around the world should be used as the weights.

No matter which weight method was used, the conclusion drawn from those researches were the same that the sophistication of China's exports of industrial product is continuously increasing. Fan *et al* (2006) found out that the sophistication of both China's exports and imports were increasing and the sophistication of the exports increased faster. The products of upper middle sophistication were the ones that grew fastest among all the products exports and in 2003, the mid technology products replaced the low tech ones as the largest group of exports. Du *et al* (2007) analyzed China's exports data and reached the conclusion that the percentage of both low and high technology products decreased while that of the mid technology product increased during 1980 to 2003. If we put this with the data from Table 2, it is quite obvious that the trend continued. Schott (2006) found that the overlap of China's products exports and those of developed countries was increasing and the sophistication of

China's exports was much higher than the countries with similar endowments. Rodrik (2006) also concluded that the sophistication of China's export was similar with those whose per capita incomes were three times as high as that of China. Besides, Cui *et al* (2007) mentioned that the calculation of IMF found that the sophistication of China's exports was increasing while that of China's imports remained the same.

Obviously, it is better to take the second method when we only measure the sophistication of the products, which is more detailed and scientific compared with the first method which was rather simple. But when we investigate the relationship between the structure of exports and other variables (export price, income or exchange rate elasticity), it is more feasible to use the first method. The first method groups exports with SITC one digit level classification into labor intensive and capital and technology intensive products, since the data on the SITC one digit level classification are very rich and of high frequency, many researchers and economic analysis organization still use this method.

To sum up, the sophistication of China's exports continues to increase, while the trade data analyses using the aggregate level data neglect the structure change of China's exports. This might lead to wrong conclusion if the researches are based on aggregate level data. Because of that, the conclusion would be more convincing if we could consider the structure of exports.

Chapter 3 Literature review

3.1 Worldwide trade elasticity studies

The research about export exchange elasticity started from finding the empirical evidence of Marshall-Lerner condition and the existence of J-curve. If the sum of export and import price elasticity is larger than 1, then the depreciation of a currency would improve the current account of a certain country as the depreciation would decrease the export price and increase the import price. The J curve describes the dynamics of the change of the current account. The depreciation would lead to the deterioration of the current account in the short run but improve the current account in the long run so that the curve of the current account is in the J

shape. Early researches focused on the estimation of export and import price elasticity such as Kreinin (1967), Houthakker *et al* (1969), Taplin (1973), Hickman *et al* (1973). Goldstein and Khan (1985) made a very complete review about these researches. Reinhart (1995), Bahmani-Oskooee (1998), Senhadji *et al* (1999) continued the research in this field. All the researches mentioned above only investigate the price elasticity and the exchange rate did not enter the econometric model. These researches assumed that the appreciation will lead to an increase of export price, however, the relationship between the exchange rate and the export price was not examined in these researches. There is also another series of researches in which the exchange rate directly entered the econometric models, such as Wilson *et al* (1979), Warner *et al* (1983), Bahmani-Oskooee *et al* (2005).

All the researches used the most popular estimation methods at that time. The early researches (before 1990s) used OLS and GLS (Kreinin (1967), Houthakker *et al* (1969) with OLS, Wilson *et al* (1979) with GLS) and when the concept of co-integration appeared around 1990s, many researches used co-integration to estimate the price or the exchange rate elasticity (Reinhart (1995), Bahmani-Oskooee (1998, 2005), Senhadji *et al* (1999)).

All the researches above mentioned used the trade data on the aggregate level to estimate the price or exchange rate elasticity. As is mentioned above, the estimation based on the aggregate level neglected the structure change and trend of the exports and imports. Based on these researches, researchers analyzed the structure and the partners of trade in the following two ways: one series of researchers studied multi-lateral trade relationship (such as Marquez (1990), Bahmani-Oskooee *et al* (2004)) or bilateral trade relationship (Haynes (1986)); the other series of researchers studied the price and exchange elasticity based on the classification of products such as Bahmani-Oskooee *et al* (2006). Moreover, several researches studied the structure of trade on bilateral trade relationship and estimated the price and exchange rate elasticity (such as Breuer *et al* (2003), Bahmani-Oskooee *et al* (2007)).

3.2 China's trade elasticity studies⁷

The estimation of China's trade elasticity was done for the first time by a famous economist in China Yining Li in 1990. Using the Chinese data from 1970 to 1983, Li found China's import and export price elasticity were 0.687 and 0.051 respectively. Dai (1997) also used the simple OLS to estimate the price elasticity and found out that relative price elasticity of import and export was 0.3 and 1.03 respectively. All these researches only used the simple OLS estimation which neglects the possibility that the macroeconomic data may be non-stationary.

More researches about the elasticity of trade appeared after 2000 when many econometric methods were introduced into China. Lu *et al* (2005) used co-integration and estimated the exchange rate elasticity of import and export by using monthly trade value data from 1994 to 2003. The study estimated the import and export real effective exchange rate elasticity were 1.96 and 1.88 respectively. Xu *et al* (2006) and Feng (2007) also used co-integration and the annual trade value data from 1985 to 2005 and from 1985 to 2004 and estimated the import real effective exchange rate elasticity to be 0.37 and 0.34 and the export real effective exchange rate elasticity to be 0.41 and 1.46.

All the researches mentioned above studied the trade elasticity on the aggregate level. After classifying the products in to labor and capital and technology intensive products, Zeng *et al* (2007) found that the real exchange rate elasticity of China's export is very small by using the trade volume data, but the elasticity was larger for labor intensive products. But Ma *et al* (2010) using the trade value data found that the real exchange rate elasticity was larger for capital and technology products based on the same products classification. Cui and Syed (2007) using the methods from Rodrik (2006) to classify the sophistication of products found out that the more sophisticated the product was the higher the exchange rate elasticity through panel model. Thorbeck and Smith (2010) classified the products into ordinary exports and processed exports and found out that a 10% appreciation of RMB would decrease the ordinary exports which are mainly labor intensive product exports by 12% and the processed exports

⁷ Studies about Chinese economy became a hot topic in economic research just recently, so the number of researches about China related to the topic of this paper in English is very limited. However, many Chinese scholars have conducted some research on this issue, so many papers cited in this section are in Chinese.

by 4%. Besides, Feng *et al* (2008) and Chen *et al* (2008) also estimated export real effective exchange rate elasticity based on trade value data and SITC, HS classification.

The estimations in the researches about China based on both aggregate level and disaggregated level all had the following problems: 1) Most of the researches used the trade value data to estimate the export exchange rate elasticity. The actual definition of exchange rate elasticity is based on the relationship between the exchange rate and the trade volume, so it is essential to choose the appropriate deflator and currency for measuring the trade value. Different currency and deflator may yield to different elasticity estimation. 2) Most of the research used the quarter and annual data. In order to ensure the sample size is large enough to make the econometric estimation feasible, the sample covered a rather long period. As a fast developing country, the change of China's trade is rapid and significant. A sample that covers a too long time period may include too much unnecessary information. There were many structure breaks within the time periods most of the research covered (joining WTO and the exchange rate reform), but most of the researches did not include the structure breaks (i.e. dummy variable for Chow test) in the econometric model. Qiang *et al* (2004) and Zeng *et al* (2007) used the index developed by Cerra *et al* (2002) and avoided the problems of currency and deflator, but they only used the simple OLS estimation which neglected that the variables might be non-stationary.

Among these researches, there is also a debate about the export exchange rate elasticity of different products. Using the annual trade data from 1993 to 2005, Cui and Syed (2007) found that the more sophisticated products have higher export exchange rate elasticity through fixed effect panel data models. Also Aziz and Li (2008) concluded that more sophisticated products had higher exchange rate elasticity by using quarterly trade data from 1995 and 2006. They used dynamic ordinary least square (DOLS) and rolling estimation and found out that the export exchange rate elasticity increased while the sophistication of China's exports increased. Both of these studies believed the more sophisticated products China exports face more fierce competitions in the international market, so the impact of RMB appreciation would be quite strong, but neither of them considered the structure breaks which is the huge impact towards

China's international trade when it joined WTO. On the other side, based on the trade data from 1987 and 2006, Thorbecke and Zhang (2008) also used DOLS and found out that the appreciation of the RMB would significantly reduce the export of labor intensive products. A 10% appreciation the RMB real effective exchange rate would lead to a 18% decrease of labor intensive products exports. The study by Oguro (2011) about the intra-industry trade also found out that the products with higher level of intra-industry trade would have lower exchange rate elasticity and these products are mainly capital and technology intensive products. The appreciation of Japanese Yen during the 1980s and the change of Japanese export also proved that the exchange rate elasticity of capital and technology intensive products is smaller.

The opposite results of the export exchange rate elasticity of different products also mean the opposite policy implications of exchange rate policy. If the more sophisticated products or capital and technology intensive products have higher export exchange rate elasticity, then as the percentage of capital and technology intensive products exports increases, China should keep a stricter control of the exchange rate so as to limit the impact of currency appreciation shocks towards the whole economy. Also since the appreciation would affect those enterprises producing capital and technology intensive products more negatively, when China is trying to upgrade its industrial structure, it should again keep a stricter exchange rate control and rely more on domestic industrial policies. On the other hand, if the more sophisticated products or capital and technology intensive products have lower export exchange rate elasticity, then Chinese government should gradually loosen its control towards the exchange rate control so that it can get a more independent monetary policy and control the inflation more easily. Also it would force the enterprises with less sophisticated or labor intensive products to move up the value chain and finally upgrade its industrial structure.

Chapter 4 Estimating export exchange rate elasticity based on trade volume data

In this section, I first estimate the export price elasticity without the exchange rate variable directly entering the econometric model, which follows the models of earlier studies. The

export exchange rate elasticity could be expressed as $\frac{DLnQ}{DLnER}$, which could be further expressed as $\frac{DLnQ}{DLnP} \bullet \frac{DLnP}{DLnER}$. This means the export exchange rate elasticity could be expressed as the product of the export price elasticity and the export price exchange rate elasticity. Kreinin (1977) used this idea in estimating the export exchange rate elasticity for countries in Western Europe and North America. Rose and Yellen (1989) also mentioned that this idea could be used to evaluate the impact of exchange rate changes towards the export change. Qiang *et al* (2004) and Zeng *et al* (2007) also used this idea to estimate China's export exchange rate elasticity by using the simple OLS method. Since the OLS estimation is not the suitable method for the export exchange rate elasticity, their estimates were extremely small and could be neglected. Since monthly data are available at SITC one digit level, a rather short time span is needed to accumulate enough data for estimation⁸. In this way, it is easier to exclude structure breaks due to the long time span of the estimation.

4.1 The export price elasticity

4.1.1 The data and econometric model

The general customs of China started to provide monthly trade volume, price and value index data with SITC and HS classifications from 2005. These data make avoiding currency and deflator issues possible and also make estimating the actual export elasticity which is more close to its original definition possible.

In their review, Goldstein and Khan (1985) divided the international trade models into the imperfect substitutes models and perfect substitutes models. For the products that are highly standardized such as commodities, it is more appropriate to use the perfect substitutes model. These differences between the products from different countries are small and they could easily substitute each other in the market. Under SITC classification, products under SITC1-4 are mainly foods, materials and natural resources. These products are highly standardized and can be easily substituted by products from other countries, so the perfect substitutes model is

⁸ A major concern about using a sample with rather short time span is that the data may not have enough variations to support a statistical estimation. However, the sample of this paper luckily includes part of the boom period, the whole period of the financial crisis and the following slight economic recovery and provides enough variations for an estimation.

more appropriate. But for products under SITC5-8, which are categorized under industrial products, the perfect substitutes model does not suit any more. If these products can be easily substituted, then Goldstein and Khan claimed that we should observe the products from one country would swallow up the whole market when products are produced under constant or decreasing costs and a country would either be the importer or the exporter of certain products. Both of the claims go against the facts, the perfect substitutes model should be rejected and the imperfect substitutes model may offer a better explanation.

Under the two country (domestic and foreign) model, the export demand function of the domestic country could be derived from the utility maximization of the consumers in the foreign country. Assume all the commodities are measured in the same currency. The foreign consumers maximize $U = U(Q_D, Q_F)$ with the budget constraint $P_D Q_D + P_F Q_F = I_F$ in which Q_D represents the export quantity of domestic products and P_D represent the export price of domestic products. Q_F represents the quantity of foreign products and P_F represents the price of foreign products and I_F represents the income of foreign consumers. Under utility maximization, the export demand function of the domestic country could be written as $Export_{Dm} = D(P_D, P_F, I_F)$ and the export supply is the difference between the total production and domestic consumption. This imperfect substitutes model of two countries could be easily transformed into the one of multiple countries. The notion P_{comp} represents the price of the products from the foreign country and those from competitor countries.

Early researches about export price elasticity (Houthakker et al (1969), Taplin (1973), Hickman et al (1973)) only used the export demand function to estimate the price elasticity. Since, the partial derivative of export price to export supply is positive, Goldstein and Khan (1985) pointed out that only estimating export demand function might have severe simultaneity problem and the estimates might be biased downwards due to the simultaneity problem and they estimated the export price elasticity of 8 industrialized countries by simultaneous equations system with export demand function and export supply function in 1978. But they also pointed out in their review that if either of the following conditions could

be met: 1) the price elasticity of export supply is infinite or 2) the export demand function is stable while the supply function shifts around, then only estimating demand function is enough. Yao (2010) and Thorbecke and Smith (2010) pointed out that there are still redundant resources in China's export sector. According to Chinese Academy of Social Sciences, China still has 150 to 200 million redundant workers in the rural area. There are 7 to 8 million new workers entering the market annually and 14 million unemployed or under employed urban labor. Moreover, China also has a quite high investment growth rate in both industries and infrastructures, and Chinese government which has quite strong controls of the economy has conducted several actions to control the redundant production capacity in several industries. Yao (2010) also found out that the export demand function of China is quite stable, so China meets the requirements for only estimating export demand function for exchange rate elasticity. Actually, most of the research regarding the export exchange rate elasticity used only the export demand function (Feng (2007), Feng *et al* (2008), Chen *et al* (2008), Aziz *et al* (2008), Cui *et al* (2007), Shu *et al* (2006)). This paper will also focus on the partial equilibrium model, estimating the elasticity with only export demand function.

The specification of the econometric model is a typical partial equilibrium model which is the export demand function model:

$$Export = \alpha_0 + \alpha_1 T + \alpha_2 P_{ex} + \alpha_3 P_{comp} + \alpha_4 Income \quad (1)$$

In equation 1, Export represents the volume of the exports, P_{ex} represents the price of the exports, P_{comp} represents the price of the competitors and Income represents the real income of the importing country. T is the time trend to represents China's deepening opening up and integration towards the global market. Since this paper needs to estimate the elasticity, the functional form of equation 1 is loglinear.

The data for Export and P_{ex} came from "China foreign trade index" published by the General Customs of China which provided the chained index based on 2005 under SITC classification from January 2006 to December 2006. The General Customs of China also

provides index data which take the export quantity and export price in the same month last year as the base (100). Combining these two streams of data, it is quite easy to calculate the chained index data of export quantity and export price. Since the general customs of China uses USD to measure China's foreign trade, the price index is calculated according to the export price measured in USD.

The monthly price data from competition countries were not available. To find a proxy for this variable, I used the import price index under SITC classification from Mexico to European Union 15 countries. The EU 15 countries are the richest countries in EU and account for a huge percentage of EU's foreign trade. Also, using EU 15 countries avoids the problem that EU has grown substantially for the recent years. The main reason to using the price data from Mexico is that Mexico and China are widely considered to have similar industrial and export structures. To test that the model is not only for specific data, this paper also use a competitor price index⁹ which is calculated from the import price data of EU 15 from both ASEAN countries and Mexico. Products from Mexico and ASEAN countries are the major competitors of Chinese export products in the developed markets. For the developing markets in Asia and Latino America, these indexes could also serve as a proxy of the prices of competitors in the local markets. The data come from EUROSTAT Comext database.

Most of the previous researches used GDP as the proxy of the income of the importing countries. Since the monthly data are used in this paper, while GDP data is announced annually, I used the industrial production data from World Bank Global Economic Monitor as the proxy of GDP. The industrial production is the sum of the data from Argentina, Australia, Brazil, India, Japan, South Korea, Mexico, Russia, Saudi Arabia, South Africa, the United States, Canada, and the EU 15 countries and ASEAN countries.

In order to avoid the problem that different variables are in different units, following Feng(2007), Feng *et al* (2008) and Chen *et al* (2008), all the variables are indexed based on the average number of 2005. The span of the data is from January of 2006 to September of

⁹ The detailed calculation process is provided in Annex 1.

2011. A general picture of the data could be seen from Exhibit 6 and Exhibit 7.

Exhibit 6 Data used in estimation for capital and technology intensive products

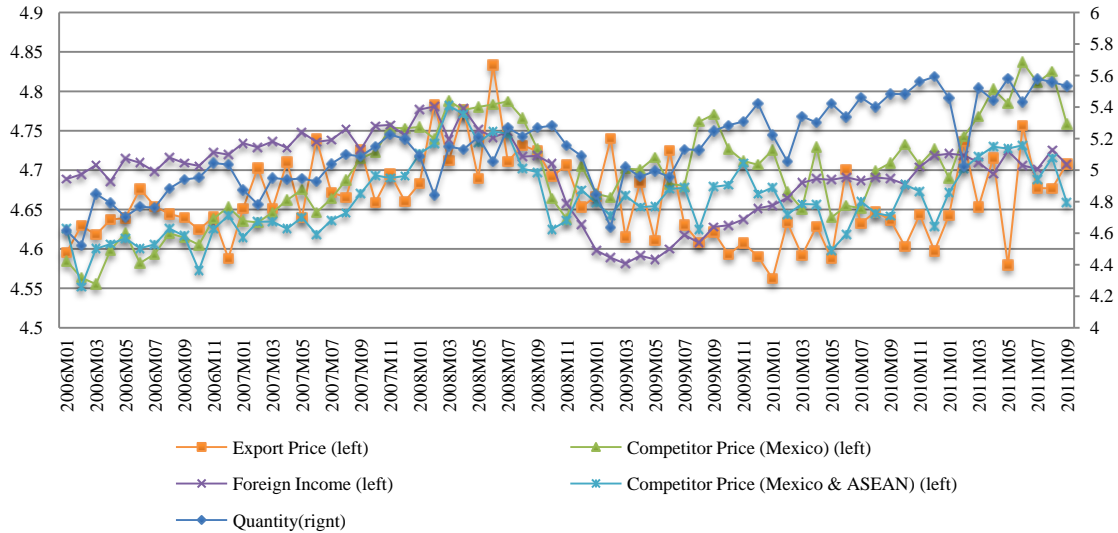
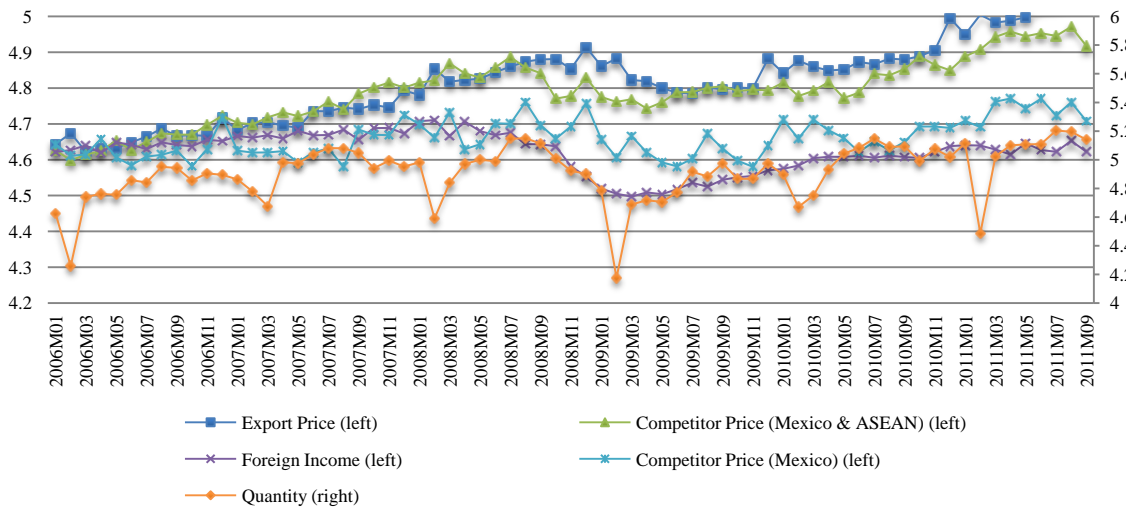


Exhibit 7 Data Used in Estimation for labor intensive products



4.1.2 Estimation of econometric model

As is mentioned above, early studies about the price elasticity usually used the simple OLS to estimate the coefficient. In researches about China, Zeng *et al* (2007), Qiang *et al* (2004) only put the current period price and income in the econometric model and neglected the lagged effects. For estimations using monthly data, it is necessary to consider the lagged data to ensure the estimation of the econometric model is reliable. When using OLS, the possibility

that the data might not be stationary is neglected and this would yield the problem of spurious regression. To avoid this problem, co-integration is used in the study. Co-integration was initially proposed by Engel and Granger that even some variables are not stationary, their linear combination might be still stationary. If the linear combination is stationary, then this combination represents the long run stable relationship of the variables. Engel and Granger (1987) proposed the two-step method for testing co-integration. But in practice, the form of the regression needed to be set arbitrarily, and it is not quite practical. To overcome this problem, Johansen (1991) proposed Johansen test for co-integration based on VAR model. But when the sample size is small, VAR model is not suitable any more as it consumes too much degree of freedom. Both of the methods abovementioned require one condition that all the variables follow the I(1) process. Pesaran *et al* (2001) proposed a new method based on Autoregressive Distributed Lagged model (ARDL) and a new bound test to test co-integration and estimate the long run stable relationship among variables. The method permits the variables to be either I(0) or I(1) process and more suitable for studies with small sample size.

As is mentioned above, products classified under SITC6 manufactured goods classified chiefly by material and SITC8 miscellaneous manufactured articles are grouped as labor intensive products, while those classified under SITC5 chemical and related products and SITC7 Machinery and transport equipment are grouped as capital and technology intensive products. Here, the study ignored SITC9 commodities and transactions not classified elsewhere as the amount is small and it is very hard to classify these products. Based on the above classification, equation (1) could be re-written as:

$$Export_i = \alpha_0 + \alpha_1 T + \alpha_2 P_{ex,i} + \alpha_3 P_{comp,i} + \alpha_4 Income \quad (1a)$$

In (1a), $i=h, 1$, where h represents capital and technology intensive products under SITC5 and SITC7, and 1 represents labor intensive products under SITC6 and SITC8. The data in equation (1a) are calculated from the data retrieved from the data source abovementioned and the detailed calculation process is provided in Annex1.

The new co-integration method proposed by Pesaran *et al* (2001) does not require all the data unanimously follow either I(1) process, however, it still requires all the data follow either I(0) or I(1) process. Table 3 displays whether the variables follow I(0) or I(1) process by using the popular ADF (Augmented Dickey Fuller Test). $P_{MX,i}$ and $P_{AM,i}$ represent the price index of Mexican exports towards EU15 and the calculated export price index based on export price index of both Mexico and ASEAN countries towards EU15.

Table 3 The ADF Test¹⁰

Variables	ADF	Test Form	Variables	ADF	Test Form
$Export_h^{***}$	-4.875	(c, t, 0)			
$Export_l^{***}$	-4.808	(c, t, 0)			
$P_{ex,h}$	-1.680	(c, 0, 8)	$DP_{ex,h}^{***}$	-2.737	(0, 0, 10)
$P_{ex,l}$	-0.068	(c, 0, 9)	$DP_{ex,l}^{***}$	-5.218	(0, 0, 1)
$P_{AM,h}^*$	-2.796	(c, 0, 0)			
$P_{AM,l}$	-1.500	(c, 0, 0)	$DP_{AM,l}^{***}$	-9.071	(0, 0, 0)
$P_{MX,h}$	-2.377	(c, 0, 0)	$DP_{MX,h}^{***}$	-9.809	(0, 0, 0)
$P_{MX,l}$	-1.990	(c, 0, 2)	$DP_{mx,l}^{***}$	-9.490	(0, 0, 1)
$Income$	-2.558	(c, 0, 3)	$DIncome^{***}$	-2.698	(0, 0, 3)

As is seen from table 3, all the variables in equation (1a) follow either I(0) or I(1) which meet the requirements of the newly proposed ARDL (Autoregressive Distributed Lag)-ECM (Error Correction Model) method for co-integration proposed by Pesaran *et al* (2001). According to Pesaran *et al* (2001), equation (1) could be written as the following Error correction model (ECM) in which p is the maximum lag number:

¹⁰ (c, t, k) represents the form of the test in which c represents the intercept, t represents the time trend and k represents the number of lags. The number of lags is determined by AIC Akaike Information Criterion. ***, **, * represent to reject the null hypothesis at the level of 1%, 5% and 10%. The bound was calculated by Mickinnon through simulation.

$$\begin{aligned} \Delta Export_t = & c_0 + c_1 T + \sum_{m=1}^{p-1} \beta_i \Delta Export_{t-m} + \sum_{m=0}^{p-1} \gamma_i \Delta P_{ex,it-m} + \sum_{m=0}^{p-1} \delta_i \Delta P_{comp,it-m} \\ & + \sum_{m=0}^{p-1} \eta_i \Delta Income_{t-m} + \varphi_0 Export_{t-1} + \varphi_1 P_{ex,it-1} + \varphi_2 P_{comp,it-1} + \varphi_3 Income_{t-1} + u_t \end{aligned} \quad (2)$$

To test the existence of co-integration, we need to calculate the F statistics on the null hypothesis that $\varphi_0 = \varphi_1 = \varphi_2 = \varphi_3 = 0$ for specific p. But different from the common F test, the F statistics needs to be compared with a new bound created by Pesaran *et al* (2001) from simulation. According to Pesaran *et al* (2001), the bound is dependent on the number of variables in equation which represents the long run stable relationship (equation (1a)). F statistics is different when different p is chosen; however, the bound is independent of lag number p. If the F statistics is larger than the upper bound, then we can reject the null hypothesis that there is no co-integration; if the F statistic is smaller than the lower bound, then we cannot reject the null hypothesis; if the F statistic is in the middle of the upper and lower bound, then it is unclear whether there is co-integration.

Table 4 displays the F statistics, AIC (Akaike Information Criterion), SBC (Schwartz's Bayesian Information Criterion)¹¹ and other related statistics. κ_{sc}^2 statistics tests the null hypothesis that there is no serial correlation among the error term u_t and the competition country is Mexico. We could select the best lag number considering the different statistics. Since an increase of lag number will increase the possibility to have serial correlation among error terms in equation (2) and the sample size is limited, we take p=6 to be the maximum lag number. Table 5 shows the similar statistics when $P_{AM,i}$ is used for the competitor's price.

Table 4 The statistics of equation (2) (Mexico as the competitor)¹²

i = h						
p	F ¹³	AIC	SBC	\bar{R}^2	$\kappa_{sc}^2(1)$	$\kappa_{sc}^2(4)$
1	7.5773***	54.7525	45.1084	0.60574	0.4633	6.8761

¹¹ For a detail description of AIC and SBC, please refer to Annex 2.

¹² *, **, *** represent to reject the null hypothesis at 1%, 5% and 10% level.

¹³ With time trend and intercept, the upper bounds to reject the null hypothesis at 1%, 5% and 10% level are 6.36, 5.07, and 4.45.

2	7.6236***	53.9062	39.9759	0.61476	0.15413	8.2021*
3	5.4979**	52.7282	34.5115	0.61715	1.3714	8.4521*
4	7.342***	61.5787	39.0758	0.7211	0.79264	4.8118
5	6.0744**	62.9827	36.1936	0.74039	0.12851	1.6007
6	3.6166	63.3991	32.3237	0.7478	0.26713	4.7896
i = 1						
1	4.6817*	32.0836	22.4395	0.42279	0.39968	1.0248
2	4.8992*	31.2349	17.3045	0.43596	1.3325	2.172
3	4.414*	34.3755	16.1589	0.51126	1.2317	1.8026
4	3.6059	36.6095	14.1066	0.56083	1.55E-04	7.0268
5	5.0203*	38.7265	11.9373	0.60027	5.4317**	17.4252***
6	5.7745**	39.39	8.3145	0.61472	14.9266***	19.904***

Table 5 The statistics of equation (2) (Mexico and ASEAN countries as the competitor)

i = h						
p	F	AIC	SBC	\bar{R}^2	$\kappa_{sc}^2(1)$	$\kappa_{sc}^2(4)$
1	6.9024***	53.9981	44.354	0.59618	0.1536	7.9265*
2	7.9072***	53.8739	39.9436	0.61437	0.33497	6.3782
3	5.4114**	51.9691	33.7524	0.60781	0.013367	6.6871
4	6.4776***	54.2854	31.7824	0.6485	1.3732	17.3322***
5	10.4071***	61.6093	34.8201	0.72882	3.2155*	8.2964*
6	3.3177	61.2559	30.1804	0.73004	0.43853	7.4806
i = 1						
1	6.4016***	30.3726	20.7285	0.39057	0.3894	3.1305
2	6.5547***	31.1566	17.2263	0.43456	4.1142**	4.426
3	4.574*	35.0933	16.8767	0.52227	0.057124	1.9126
4	2.7972	36.4256	13.9227	0.55826	0.77976	5.8067
5	5.3555**	42.1024	15.3132	0.6409	9.7766***	23.5871***
6	7.4061***	45.4531	14.3777	0.68218	14.8094***	18.9161***

When $i=h$, Mexico is the competitor and the lag number $p=3$, F statistic is larger than the upper bound at 5% level, AIC is the smallest and SBC is quite small. Also, the problem of serial correlation among error terms is not serious. So it is quite obvious to take $p=3$ to be the best maximum lag number. Once the lag number is determined, we could choose the best ARDL specification from $4^{(3+1)} = 256$ by using AIC, SBC and HQ (Hannan-Quinn Criterion)¹⁴ and find out the long run stable relationship among the variables in equation (1a). With $p=3$, ARDL(1,2,0,0) is the best specification among all the specifications according to AIC. The long run coefficient for $P_{ex,h}$ is -0.47, which means the price elasticity of capital

¹⁴ For a detailed description, please refer to Annex 2.

and technology intensive goods is 0.47, but the coefficient is not significant. Through the same method, $p=2$ is found to be the best maximum lag number for the situation when $i=l$ and Mexico is the competitor. Also, $p=3$ and $p=1$ is also the best maximum lag numbers for the situations when $i=h$ and $i=l$ and the combination of Mexico and ASEAN countries is the competitor respectively. Table 6 displays the best specifications and the long run coefficient for the long run stable relationship. The coefficients of the corresponding Error Correction Model and relevant statistics of the corresponding ARDL model are listed in Table 6.

Table 6 The long run coefficients of equation (1a), the coefficients for the ECM and relevant statistics for the corresponding ARDL model

	Mexico		Mexico and ASEAN	
	C&T intensive	Labor Intensive	C&T intensive	Labor Intensive
Long run relationship				
ARDL	(1,2,0,0)	(1,1,0,0)	(1,2,0,0)	(1,1,0,0)
$P_{ex,i}$	-0.470 (0.537)	-2.338** (1.140)	-0.427 (0.534)	-2.008* (1.068)
$P_{comp,i}$	0.041 (0.457)	1.989* (1.041)	-0.026 (0.526)	1.813 (1.132)
$Income$	2.002*** (0.365)	2.089*** (0.680)	2.015*** (0.358)	1.715** (0.764)
ECM coefficients				
DP_{ex}	-1.713*** (0.280)	-1.639*** (0.536)	-1.708*** (0.287)	-2.335*** (0.722)
$DP_{ex,-1}$	-0.589* (0.309)		-0.602** (0.292)	
DP_{comp}	0.028 (0.316)	1.305** (0.508)	-0.018 (0.364)	1.070* (0.616)
$DIncome$	1.383*** (0.339)	1.161** (0.436)	1.393*** (0.338)	1.013** (0.492)
EC_{t-1}	-0.691*** (0.117)	-0.621*** (0.119)	-0.691*** (0.117)	-0.590*** (0.122)
ARDL Statistics				
\bar{R}^2	0.753	0.420	0.849	0.418
$K_{sc}^2(1)$	1.954	0.060	0.0008	0.213
$K_{sc}^2(4)$	5.549	1.293	6.756	2.256
CUSUM	Stable	Stable	Stable	Stable
CUSUMSQ	Stable	Stable	Stable	Stable

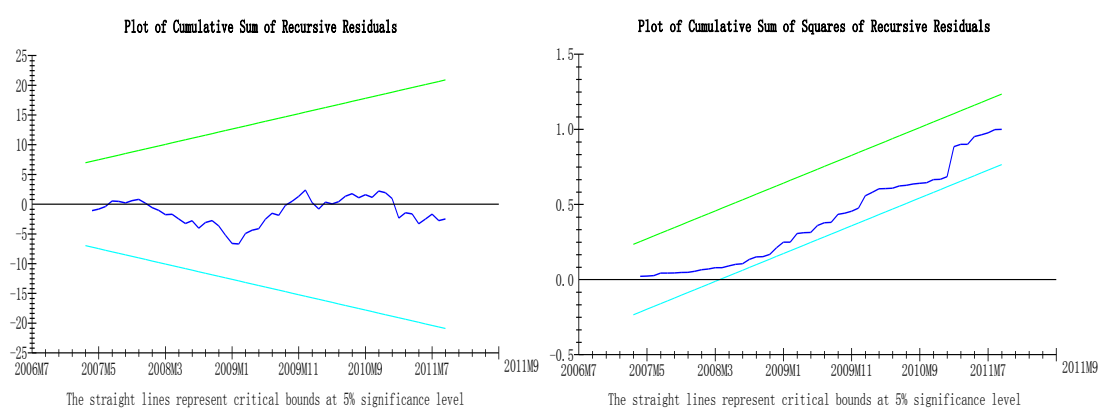
By comparing the long run coefficients, it is obvious that there is a substantial difference between the export price elasticity between labor intensive products and capital and technology intensive products. When Mexico is taken as the competitor, the estimated coefficient for the variable $P_{ex,i}$, which is the export price elasticity of capital and technology intensive products is 0.47 and statistically insignificant, while the estimated price elasticity of labor intensive products is 2.338 and statistically significant at 5% level. The estimation is a little different when the combination of Mexico and ASEAN countries are taken as the competitor, however, the conclusion from the estimation remains. The price elasticities of capital and technology intensive products and labor intensive products are 0.427 and 2.008 respectively and the former is also statistically insignificant. The estimated long run coefficients for the variables $P_{comp,i}$ and *Income* are mainly positive (the only negative result turns out to be statistically insignificant and the corresponding p value is quite high), which means that the increase of the competitor's price and the income of the foreign consumers will increase China's export for both groups of the products and are in accordance with the prediction of the theories. The estimated coefficient of the export price is quite close to that of the competitor's price for labor intensive products. This might imply that for labor intensive products, the relative price between Chinese exports and exports from other competing countries matters while for capital and technology intensive products, it is still the absolute export price that matters.

The estimations of the coefficients in the corresponding error correction model presents the short run dynamics of the variables and most of the coefficients are in accordance with the theories. The corresponding ARDL models all have relatively high \bar{R}^2 and the K^2 statistics show that there are no serious serial correlations among the error terms in the ARDL models.

Even though the relevant estimations and statistics have shown some good qualities of the econometric model, there is still one more potential problem that we need to address. Since China is among the fastest growing countries in both the domestic and foreign sectors, there

might be structure breaks. If so, then the coefficients estimated from the model might be wrong and provide the wrong policy implication. The typical method to solve the problem is the famous “Chow test”, which is designed to identify the structure changes. However, the choice of the timing of the structure changes is arbitrary. Brown (1975) proposed to use CUSUM statistics and CUSUMSQ statistics to identify the structure changes. Exhibit 8 illustrates the CUSUM and CUSUMSQ statistics of the ARDL model for capital and technology products with Mexico as the competitor. The two straight lines represent the 5% boundary. If the statistics remain in the 5% boundary, then we can say that there is no significant structure break within the sample period. It is obvious from Exhibit 8 that the CUSUM and CUSUMSQ statistics remains in the boundary, so the coefficients estimated by the model and the long run stable relationship is reliable. And Table 6 has also shown that the CUSUM and CUSUMSQ statistics for the other ARDL models are also stable, which means that it is not necessary to consider about the structure break during the span of the sample period.

Exhibit 5 CUSUM and CUSUMSQ statistics



The big difference between the export price elasticities of capital and technology intensive products and labor intensive products could possibly be explained by China’s growing advantages in medium and high technology production and its decreasing advantages in low technology production. As is mentioned above in chapter 2, both the percentage of the capital and technology products of all the industrial products exports and the index which describes the sophistication of China’s exports proves that the sophistication of China’s exports is

increasing and China has transformed from a country exporting low value added and low technology products to one exporting mid value-add and mid-technology products. These increases are the demonstrations of China's growing advantages in producing mid-technology products. China's huge investments on technology, the fast growing number of technicians and engineers and the workers with higher education allow China to gain and increase its advantages in producing more sophisticated products. These advantages enable the products to remain on the advantageous position in the competition even the prices increase. The improving infrastructure has made many countries such as many ASEAN countries which could provide cheaper labors competitive places for labor intensive low technology production. Moreover, China's increasing labor cost due to high inflation has also made countries like Mexico which was once not as competitive as China competitive again in producing labor intensive low technology products. It is quite reasonable to have a higher export price elasticity when the competition in market increases.

4.2 The export exchange rate elasticity

If the export price and the exchange rate follow the one for one change, then from the estimation in the previous model, it is quite obvious that China's labor intensive products have a much higher export exchange rate elasticity than the capital and technology intensive products. But do export price and exchange rate follow one for one change? Does the price level of different products change the same when the currency appreciates or depreciates for 10%? As is mentioned above, the export exchange rate elasticity could be expressed as the product of export price elasticity and export price exchange rate elasticity. Since the export price elasticity has been estimated, once the export price exchange rate elasticity is estimated, it is easy to calculate the export exchange rate elasticity through these estimations.

There are serials of researches that study how much the export price would change if the exchange rate changes which is called exchange rate pass through (ERPT). The study about the relationship between the exchange rate and the export prices is one of the major concerns in this subject. Goldberg and Knetter (1997) made a thorough review of the literature on ERPT in export sector. According to the law of one price, if the exports are measured in the

foreign currency (say USD), then there should be a one for one change of the exports prices if the exchange rate changes provided the law of one price holds. Unfortunately the empirical studies have shown that the export prices do not change one for one when exchange rate changes. Using the natural experiment which is the exchange rate re-adjustment between the USD and major industrial economies' currencies after the collapse of the Bretton Woods System in the 1970s, Kreinin (1977) found the exchange rate pass through was from 20% to 125%. Using the prices of Japanese car and motorcycle exports towards the U.S., a study conducted by Feenstra (1989) estimated that the exchange rate pass through was from 63% to 100%. There are also some studies mainly in Chinese which studies the exchange rate pass through of the RMB. Bi *et al* (2007), Chen *et al* (2007) both estimated the change of the export prices when the RMB real effective exchange rate changes and they all found that there is no or only partial exchange rate pass through for different products exports.

One of the major explanations for the partial exchange rate pass through in the export sector is from the perspective of the industrial organizations. In the market with imperfect competition, in order to keep the market share, the producers absorbed partial shock of the exchange rate changes by adjusting the profit margin which in turn result in the partial exchange rate pass through. An interesting study conducted by Yuan *et al* (2007) used the industrial data in China in 2007 and found out that the profit margins of labor intensive products producers were more severely affected when the RMB appreciates and those of capital and technology intensive products producer were less affected by the appreciation.

Also, the percentage of imported inputs in the products exported may result in different exchange rate pass through. US dollar is still the main currency that is used for international trade. Since both the imported inputs and the exported products are traded in USD, producers of the export products could actually hedge part of the exchange rate changes. The higher the percentage of imported inputs in the products exported, the more producers can hedge.

Based on the studies about the exchange rate pass through, the model specification to estimate the price exchange rate elasticity is as follows:

$$P_{ex,h} = \theta_0 + \theta_1 T + \theta_2 E + \theta_3 PPI + \theta_4 P_{comp,h} \quad (3a)$$

$$P_{ex,l} = \phi_0 + \phi_2 E + \phi_3 PPI + \phi_4 P_{comp,l} \quad (3b)$$

In both equation (3a) and (3b), $P_{ex,h}$ and $P_{ex,l}$ are the export prices for the two groups of products, capital and technology intensive ones and labor intensive ones. $P_{comp,h}$ and $P_{comp,l}$ represent the competitor's price which are the same as the variables in equation (1a). All the price index are measured in USD. PPI¹⁵ (Producer Price Index) is used to represent the production costs of producers¹⁶ and the data is from Statistics Bureau of China. E represents the exchange rate of RMB. There are usually two options for the variable exchange rate, namely the nominal and the real effective exchange rate. These two variables are both indexed and available in BIS (Bank of International Settlement) Database and IMF IFS database. The nominal effective exchange rate index is a weighted sum of bilateral nominal exchange rate in which the weights are the percentages the bilateral trade value takes in China's aggregate trade value and the real effective exchange rate is the nominal exchange rate adjusted by price index and measure the exchange rate of different currencies based on purchasing power. Compared with the exchange data from IMF, those from BIS make a more thorough adjustment for the bilateral trade value, thus providing a better measure of exchange rate. So, in this paper, the data from BIS is applied and since the production costs have been represented by the variable PPI, the nominal exchange rate index is applied in equation (3a) and (3b). The index increases when the RMB appreciates. T is the time trend. The specification takes the following consideration: 1) T is included in equation (3a) to represent the technology progress which has a downward pressure on the price of capital and

¹⁵ There are mainly three ways to find the proxy for production costs. Index such as PPI or CPI could serve as the proxy of production costs. One could also use capital cost (interest rate), labor cost (wage rate) and energy cost (prices of major commodities) to represent production cost. Chinese statistic bureau has quite rich data in PPI and CPI. However, since food accounts for a big proportion in the calculation of CPI and the food prices have gone up substantially in the recent years, CPI is not an appropriate proxy for production costs. There is also a very severe availability problem about China's labor statistics. Considering all these facts, PPI is a better proxy for production costs.

¹⁶ PPI, Producer Price Index measures the prices of products when the production phase is complete. Since China does not have systematical statistics about labor cost, PPI could serve as a good proxy of production cost.

technology intensive products. Since such progress is unlikely to happen in labor intensive products production, T is not included in equation (3b). 2) As is mentioned above, China has huge redundant production capacity, so the change of export prices are more likely to be influenced by the exchange rate, the production costs and the price of the competitors rather than the foreign demand. Also there is severe multicollinearity between the variable PPI and Income. Since the variable PPI is more relevant for price determination, the variable Income is excluded in the model. Exhibit 8 and Exhibit 9 give general pictures of the data in the model.

Exhibit 8 Data for equation (3a)

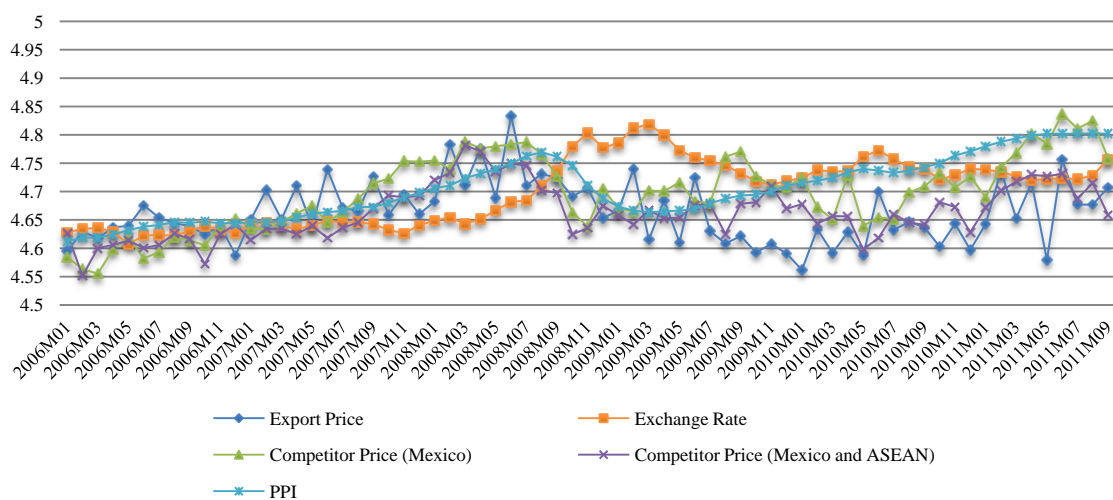
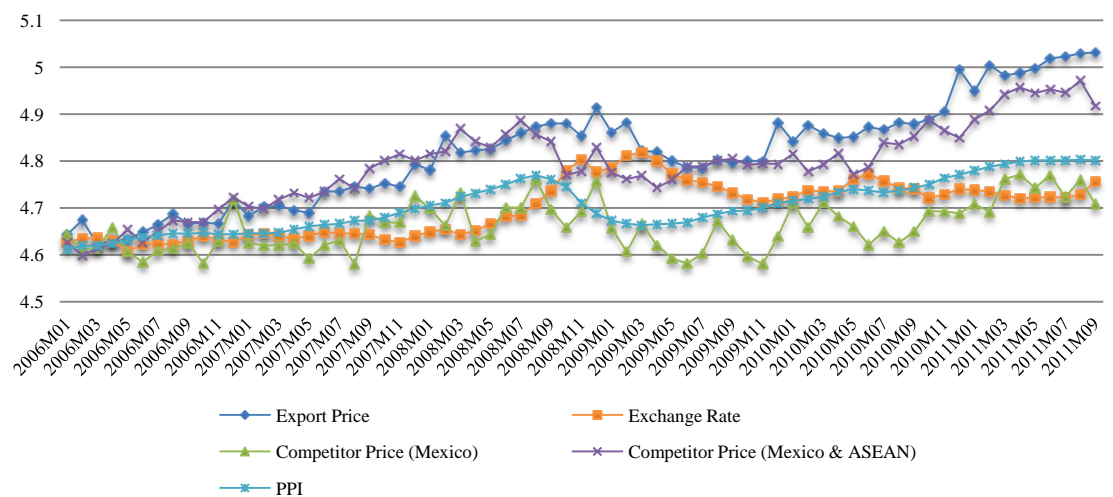


Exhibit 9 Data for equation (3b)



Before any estimation could be made, the test to examine whether the new variables are stationary needs to be taken and table 7 presents the ADF tests for the new variables.

Table 7 ADF test of the new variables

Variables	ADF	Test Form	Variables	ADF	Test Form
E	-1.352	(c, 0, 1)	DE***	-5.197	(0, 0, 0)
PPI	1.111	(c, 0, 2)	DPPI***	-3.032	(0, 0, 1)

Following the same procedure proposed by Pesaran *et al* (2001), equation (3a) and (3b) could be written as the following error correction model:

$$\begin{aligned} \Delta P_{ex,ht} = & c_0 + c_1 T + \sum_{m=1}^{p-1} \beta_i \Delta P_{ex,ht-m} + \sum_{m=0}^{p-1} \gamma_i \Delta E_{t-m} + \sum_{m=0}^{p-1} \delta_i \Delta PPI_{t-m} \\ & + \sum_{m=0}^{p-1} \eta_i \Delta P_{comp,ht-m} + \varphi_0 P_{ex,ht-1} + \varphi_1 EER_{t-1} + \varphi_2 PPI_{t-1} + \varphi_3 P_{comp,ht-1} + u_t \end{aligned} \quad (4a)$$

$$\begin{aligned} \Delta P_{ex,lt} = & c_0 + \sum_{m=1}^{p-1} \beta_i \Delta P_{ex,lt-m} + \sum_{m=0}^{p-1} \gamma_i \Delta E_{t-m} + \sum_{m=0}^{p-1} \delta_i \Delta PPI_{t-m} + \sum_{m=0}^{p-1} \eta_i \Delta P_{comp,lt} \\ & + \varphi_0 P_{ex,lt-1} + \varphi_1 EER_{t-1} + \varphi_2 PPI_{t-1} + \varphi_3 P_{comp,lt-1} + u_t \end{aligned} \quad (4b)$$

Comparing F statistics which test the hypothesis that $\varphi_0 = \varphi_1 = \varphi_2 = \varphi_3 = 0$ with the boundary, we can find whether co-integration stands for different lag numbers. With Mexico as the competitor, p=1 is the best maximum lag number for both capital and technology intensive products and labor intensive products. With the combination of Mexico and ASEAN as the competitor, p=1 is still the best maximum lag number both of the groups. Table 8 displays the estimations of long run coefficients, the corresponding error correction model and the relevant statistics of ARDL models.

Table 8 Long run coefficients for equation (3a) and (3b), the coefficients for ECM and relevant statistics of ARDL models

	Mexico		Mexico and ASEAN	
	C&T intensive	Labor Intensive	C&T intensive	Labor Intensive
Long run relationship				
ARDL	(1,0,0,0)	(1,0,0,0)	(1,0,0,0)	(1,0,0,0)
E	0.446*** (0.132)	0.519*** (0.124)	0.420*** (0.123)	0.511** (0.108)
PPI	0.910*** (0.195)	1.489*** (0.223)	0.861*** (0.186)	1.125*** (0.286)
$P_{comp,i}$	0.321*** (0.113)	0.223 (0.159)	0.430*** (0.124)	0.371 (0.182)
T	-0.004*** (0.0006)		-0.004*** (0.0006)	
ECM coefficients				
DE	0.545*** (0.173)	0.273*** (0.102)	0.528*** (0.165)	0.302*** (0.103)
$DP_{comp,i}$	0.393*** (0.147)	0.117** (0.090)	0.540*** (0.167)	0.219* (0.124)
$DPPI$	1.111*** (0.263)	0.785*** (0.166)	1.081*** (0.257)	0.664*** (0.182)
DT	-0.005*** (0.00094)		-0.005*** (0.00089)	
EC_{t-1}	-1.221*** (0.132)	-0.421*** (0.109)	-1.256*** (0.130)	0.590*** (0.122)
ARDL Statistics				
\overline{R}^2	0.366	0.956	0.396	0.941
$K_{sc}^2(1)$	0.507	1.711	2.555	12.96**
$K_{sc}^2(4)$	2.696	7.296	7.005	15.54**
CUSUM	Stable	Stable	Stable	Stable
CUSUMSQ	Stable	Stable	Stable	Stable

The long run coefficients in table 8 shows that actually the differences of the exchange rate pass through between capital and technology intensive products and labor intensive products is small. With Mexico as the competitor, the difference of the exchange rate pass through between the two groups is 0.07; with the combination of Mexico and ASEAN countries as the competitor, the difference between the two groups is 0.09. The coefficient of T is negative and

statistically significant, which proves that the technology progress has downward pressure towards the price of capital and technology intensive products and is consistent with the theory. Besides, the long run coefficients estimated in the model are consistent with the theory.

The estimates however cannot distinguish whether the partial exchange rate pass through is from the change of profit margins or from the percentages the imported inputs take in the exported products. For capital and technology intensive products, since imported inputs take quite a large percentage in the final products of capital and technology intensive products, it is difficult to distinguish the cause of partial exchange rate pass through. The partial exchange rate pass through for capital and technology intensive products may due to the comparatively high percentages imported inputs take in the final products or the change of profit margin or both. However, for labor intensive products, usually the imported inputs take a quite low percentage in the final products, so it is likely that the partial exchange rate pass through is due to the changes of profit margin for the labor intensive producers¹⁷. The estimated exchange rate pass through in this paper for labor intensive products is quite different from the results estimated by Chen *et al* (2007), which found out that the exchange rate pass through of China's labor intensive products exports is very small. However, these differences could be possibly explained by the different sample periods taken in the estimations. The findings from Chen *et al* (2007) were based on the samples from the period when the labor costs were quite low. When labor costs were low, the relatively high profit margin allowed labor intensive producers to absorb most of the exchange rate shocks. Yuan *et al* (2011) also supported this claim by examining the profit changes of different producers when exchange rate changes. Since 2006, China has experienced a dramatic increase of labor costs and the decreasing profit margin forces producers of labor intensive products to transfer part of exchange rate shocks to the importers, which increases the exchange rate pass through.

After estimating the exchange rate pass through, it is possible to combine these with the export price elasticity to calculate the export exchange rate elasticity. As is mentioned before,

¹⁷ Even though the competition is fierce in labor intensive exports, however, the producers still have certain market power.

the export exchange rate elasticity could be calculated by taking the product of export price elasticity and the export price exchange rate elasticity. Table 9 presents the calculated export exchange rate elasticity. The export exchange rate elasticity of the capital and technology intensive products is much smaller than that of the labor intensive products. The export price exchange rate elasticity is almost the same for these two groups of the products while the export price elasticity is different.

Table 9 The calculated export exchange rate elasticity

Mexico					
C& T intensive			Labor intensive		
Export price elasticity	Price exchange rate elasticity	Export exchange rate elasticity	Export price elasticity	Price exchange rate elasticity	Export exchange rate elasticity
0.47	0.45	0.212	2.64	0.52	1.373
Mexico and ASEAN					
0.43	0.42	0.181	2.01	0.51	1.025

4.3. Estimations on the SITC one digit level

In the first two sections of chapter 4, the export exchange rate elasticity has been estimated through estimating the export price elasticity and the exchange rate pass through. After categorizing products at SITC one digit level into two different groups, capital and technology intensive products with products under SITC5 and SITC7 and labor intensive products with products under SITC6 and SITC8, the estimations reveal that the export exchange rate elasticity is much smaller for capital and technology intensive products and since the export exchange rate elasticity could be expressed as the product of export price elasticity and exchange rate pass through, the estimations also reveal that the major difference in export exchange elasticities of the two groups of products came from big export price elasticity differences while the exchange rate pass through is almost the same for both groups of the products.

The previous estimations used a quite simple and widely used rule to categorize the export products and offered clear and meaningful results of different groups of products. However,

there are still some problems with the estimations. First, the use of trade volume index in the estimation avoided the problem connected with trade value, however, in order to calculate the volume and price index for the two groups, the trade value data are still somehow involved.¹⁸ Second, in previous estimations, the classification of the products though catches the main characteristics of different products, it is quite rough and requires high level of aggregation. As is mentioned by Goldstein and Khan (1985), data may cancel each other so that some specific characteristics of different products might get hidden by aggregation. Since the data are available at SITC one digit level and the two groups are constructed according to SITC classification, the estimations at SITC one digit level could also be conducted to check whether the estimations at SITC one digit level support the conclusion from the previous classification. To use the index data purely from the general customs of China and Eurostat database, the following estimations will choose Mexico as the competitor.

In accordance with the estimations above, the model specification of products SITC5 and SITC7 follows the form of:

$$Export_i = \alpha_0 + \alpha_1 T + \alpha_2 P_{ex,i} + \alpha_3 P_{MX,i} + \alpha_4 Income \quad (5)$$

$$P_{ex,i} = \theta_0 + \theta_1 T + \theta_2 E + \theta_3 PPI + \theta_4 P_{MX,i} \quad (6)$$

In equation (5) and (6), i equals 5,7, which represents the products under SITC5 and SITC7. Likewise, the model specification for products under SITC6 and SITC8 is as follows:

$$Export_k = \alpha_0 + \alpha_1 T + \alpha_2 P_{ex,k} + \alpha_3 P_{MX,k} + \alpha_4 Income \quad (7)$$

$$P_{ex,k} = \phi_0 + \phi_1 E + \phi_2 PPI + \phi_3 P_{MX,k} \quad (8)$$

¹⁸ Please refer to Annex 1.

In equation (7) and (8), k equals 6, 8, which stands for the products under SITC6 and SITC8. Since the specifications for co-integrated model have been determined, the estimations could be conducted in the same way stated in Pesaran *et al* (2001) and conducted previously. Table 10 presents both the export price elasticity and exchange rate pass through for products under SITC5 to SITC8.

Table 10 The export exchange rate elasticity for products under SITC5 to SITC8

		Export price elasticity	ERPT	Export Exchange rate elasticity
SITC5	P	3	1	
	estimation	0.740** (0.282)	0.707*** (0.147)	0.523
SITC6	p	3	2	
	estimation	0.704 (0.534)	-0.216 (0.290)	-0.152
SITC7	p	2	1	
	estimation	0.439 (0.597)	0.409*** (0.138)	0.180
SITC8	p	1	1	
	estimation	3.046*** (1.075)	0.574*** (0.208)	1.748

As is seen in Table 10, the conclusion drawn from the estimation at SITC one-digit level does not differ much from that drawn from the estimation when products are classified into two different groups. The coefficients of exchange rate for SITC5 and SITC7 which belong to capital and technology intensive products are small while that of products under SITC8 which belongs to labor intensive products is significantly larger. The only difference remains in the products under SITC6. Both the export price elasticity and exchange rate pass through are insignificant. For products under SITC6 manufactured goods chiefly classified by material, the raw material accounts for a huge part of their prices. PPI, the production costs may not be able to fully represent the price changes of raw material and the big part the raw material take may make products under this group more like commodities rather than manufactured goods.

4.4 Sum up

By estimating the export price elasticity and exchange rate pass through, this paper calculated the export exchange rate elasticity for both capital and technology intensive products and labor intensive products. The estimations reveal that the export exchange rate elasticity of capital and technology intensive products is significantly larger than that of labor intensive products. The estimations also reveal that the main source of the difference in export exchange elasticities for the two groups of products comes from the significant export price elasticities differences while there are no significant differences between the exchange rate pass through for the two groups of products. The conclusion holds no matter Mexico or the combination of Mexico and ASEAN countries are taken as competitors and it is also supported by the estimation results on SITC one digit level products.

Chapter 5 Conclusions and the policy related issues

The issue of the RMB exchange rate has been the focus not only in the field of economics but also in that of politics. There are disputes about whether the RMB should appreciate, how much it should appreciate and how fast the appreciation should be. Due to the size of China's economy and its integration towards the world market, the appreciation of the RMB will not only affect the growth of Chinese economy but also the world economy significantly and China's foreign trade will be the first one which will be affected by the shocks.

The shock brought by the change of exchange rate towards the exports could be measured by estimating the export exchange rate elasticity. Previous researches have done many works in estimating China's export exchange rate elasticity at not only aggregate level but also disaggregated level classified by trade partners or export products. However, some of the problems in the estimations remain unsolved. Based on the monthly data from January 2006 to September 2011 and the common method for classification, this paper re-estimated China's export exchange rate elasticity and avoided the problems in previous researches. By using the new ARDL-ECM model proposed by Pesaran *et al* (2001), I have found that the export exchange rate elasticity of the more sophisticated capital and technology intensive products is

much smaller than that of the less sophisticated labor intensive products. This conclusion was reached by using both the one equation econometric model and the two step method which estimates the export price elasticity at the first stage and the exchange rate pass-through at the second stage. Moreover, this conclusion is supported by the estimations at the SITC one-digit level data.

Since the export exchange rate elasticity of capital and technology intensive products is much smaller than that of labor intensive ones and the proportion capital and technology intensive products take in China's exports is still increasing, the negative effects brought by the RMB appreciation towards China's exports would be quite limited in the long run and this may lend some support to certain exchange rate policy choice.

China's growing influence in the world economy has provided space and a great opportunity to turn the RMB into a currency that is widely used in international trade and finance. However, such transition inevitably requires China to open its capital account. According to the classical theory, the fixed exchange rate, open capital account and independent monetary policy cannot co-exist. Releasing the exchange rate control would solve the policy dilemma and provide more space for independent monetary policy but it would somehow negatively affect the exports as releasing the exchange rate control probably implies an appreciation of the RMB. The estimation and conclusion may alleviate the worry that release the exchange rate control may substantially negatively affect China's export and it could also serve as a support to the policy to release the exchange rate control.

Another support the estimations and conclusion of this paper may lend towards the policy to release the exchange rate control is that the release might also benefit China's industrial structural change. Since the labor intensive producers are more affected by the RBM appreciation, releasing the exchange rate control could somehow push the less sophisticated labor intensive producers to move to an upgraded level of production and to produce more sophisticated products. Since the number of labors that are in the working age is almost reaching its peak, China's future growth should rely more on technology progress rather than

the expansion of labor force.

However, the estimations also suggest that the government should still be cautious about the timing of the policy change and considering the current economic situation, the estimation would support Chinese government still to retain the control of exchange rate in the near future. The estimations of the error correction model have shown the short run dynamics of the change of exchange rate. In the short run, the change of exchange rate still brings quite strong shocks towards the exports. Even though the markets for China's exports have been dramatically diversified, the developed world still takes a huge account for its exports. The shaking European economy has put strong shadow on Chinese exports and China is also facing a difficult time in the domestic market. The policy to control the real estate bubble has greatly affected a long chain of industries. A change of exchange rate policy at this time may further worsen the export sector and this will drive up the unemployment when the domestic market is facing a difficult time and unable to absorb the redundant labor forces.

Reference

- Aziz, J. and X. Li, (2008): China's Changing Trade Elasticities, *China and World Economy*, 16(3), 1-21.
- Bahmani-Oskooee, M. and F. Niroomand, (1998): Long-Run Price Elasticities and the Marshall-Lerner Condition Revisited, *Economics Letters*, 61, 101-109.
- Bahmani-Oskooee, M. and G. Goswami, (2004): Exchange Rate Sensitivity of Japan's Bilateral Trade Flows, *Japan and the World Economy*, 16, 1-15.
- Bahmani-Oskooee, M. and Z. Ardalani, (2006): Exchange Rate Sensitivity of U.S. Trade Flows: Evidence from Industry Data, *Southern Economic Journal*, 72(3): 542-559.
- Bahmani-Oskooee, M. and Y. Wang, (2007): United States-China Trade at the Commodity Level and the Yuan-Dollar Exchange Rate, *Contemporary Economic Policy*, 25(3), 341-361.
- Bi, Y. and Z., Zhu (2007): The RMB exchange rate pass through effects on China's export prices, *The Journal of World Economy (in Chinese)*, 2007 (5), 3-15.
- Breuer, J. and L. A. Clements, (2003): The Commodity Compositions of US-Japanese Trade and the Yen/Dollar Real Exchange Rate, *Japan and the World Economy*, 15, 307-330.
- Brown, R. L., J. Durbin and J.M. Evans, (1975): Techniques for Testing the Constancy of Regression Relationships over Time, *Journal of the Royal Statistical Society Series B*, 37(2), 149-192.
- Cerra, V. and S. C. Saxena, (2003): How Responsive is Chinese Export Supply to Market Signals, *China Economic Review*, 14, 350-370.
- Chen, X., S. Li and D. Lu, (2007), Exchange Rate Pass-through to Chinese Export Prices and Exporters' Capability of Pricing to Market, *The Economic Research Journal (in Chinese)*, 2007 (12), 106-117.
- Chen, Y., and X. He, (2008): The Impacts of the RMB Exchange Rate Changes to China's Exports in HS Classification, *The Journal of Quantitative and Technical Economics (in Chinese)*, 2008 (3), 43-54.
- Cline, W. R. and J. Williamson, (2007): Estimates of the Equilibrium Exchange Rate of the Renminbi: Is There a Consensus and, If Not, Why Not? Paper Presented at the Conference on China's Exchange Rate Policy Peterson Institute, Washington DC, <http://www.iie.com/publications/papers/cline-williamson1007.pdf>.
- Cui, L. and M. Syed, (2007): The Shifting Structure of China's Trade and Production, IMF Working Paper, WP/07/214.

- Dai, Z., (1997): The elasticity analysis of China's Foreign Trade: 1981-1995, *The Economic Research Journal (in Chinese)*, 1997 (7), 55-62.
- Du, X. and W. Wang, (2007): Technology Structures of China's Exports and Their Changes: 1980-2003, *The Economic Research Journal (in Chinese)*, 2007 (7), 137-151.
- Engle, R.F., and C.W. J. Granger, (1987): Co-integration and Error Correction: Representation, Estimation, and Testing, *Econometrica*, 55(2), 251-276.
- Fan, G., C.Kwan and Z. Yao, (2006): Analyzing the Foreign Trade Structure Based on Technologies of Traded Goods, *The Economic Research Journal (in Chinese)*, 2006 (8), 70-80.
- Feenstra, R.C., J.E.Gagnon, and M. Knetter, (1996): Market Share and Exchange Rate Pass-through in World Automobile Trade, *Journal of International Economics*, 40, 187-207.
- Feng, S., (2007): The impacts of the RMB Real Exchange Rate Changes to China's Foreign Trade, *The Journal of Quantitative and Technical Economics (in Chinese)*, 2007 (4), 3-13.
- Feng, S. and W. Wu, (2008): The Impacts of Exchange Rate Changes to the Imports and Exports of Different Products, *The Journal of Quantitative and Technical Economics (in Chinese)*, 2008 (7), 106-117.
- Fu, C. and Y. Chen, (2006): China's Comparative Advantage in Trade: 1980-2000, *China Economic Quarterly (in Chinese)*, 5(2), 579-590.
- Goldberg, P. K., and M. Knetter, (1997): Goods Prices and Exchange Rates: What Have We Learned? *Journal of Economic Literature*, 35(3), 1243-1272.
- Goldstein, M. and M. S. Khan, (1978): The Supply and Demand for Exports: A Simultaneous Approach, *The Review of Economics and Statistics*, 60(2), 275-286.
- Goldstein, M. and M. S. Khan, (1985): Income and Price Effects in Foreign Trade, In R. W. Jones, and P. B. Kenen (eds.), *Hankbook of International Economics*, vol. II , 1041-1105.
- Goldstein, M. (2004): China and the Renminbi Exchange Rate, In C. F. Bergesten and J. Williamson (eds.), *Dollar Adjustment: How Far? Against What?* 197-230.
- Goldstein, M. and N. Lardy, (2007): China's Exchange Rate Policy: An Overview of Some Key Issues, Paper Prepared for the Conference on China's Exchange Rate Policy, Peterson Institute for International Economics.
- Haynes, S. E., M. Hutchison and R. Mikesell, (1986): U.S.-Japanese Bilateral Trade and the Yen-Dollar Exchange Rate: An Empirical Analysis, *Southern Economic Journal*, 52(4), 923-932.
- Hickman, B. and L. Lau, (1973): Elasticities of Substitution and Export Demand in a World Trade Model, *European Economic Review*, 4, 347-380.

- Houthakker, H. S. and S. Magee, (1969): Income and Price Elasticities in World Trade , *The Review of Economics and Statistics*, 51(2), 111-125.
- Johansen, S., (1991): Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models, *Econometrica*, 59(6), 1551-1580.
- Kreinin, M. E., (1967): Price Elasticities in International Trade, *The Review of Economics and Statistics*, 49(4), 510-516.
- Kreinin, M. E., (1977): The Effect of Exchange Rate Changes on the Prices and Volume of Foreign Trade, *Staff Papers-International Monetary Fund*, 24(2), 297-329.
- Kwan, C., (2002): Examining the Sophistication of Chinese Products: An Analysis about IT Products, *International Economic Review (in Chinese)*, 2002 (4)
- Lall, S., (2000): The Technological Structure and Performance of Developing Countries Manufactured Exports, 1985-1998, QEH Working Paper Series-QEHWPS 44.
- Lall, S., J. Weiss and J. Zhang, (2006): The “Sophistication” of Exports: A New Trade Measure , *World Development*, 34(2), 222-237.
- Lu, X. and G. Dai, (2005): The Influence of Fluctuation of Real RMB Exchange Rate to Chinese Import and Export: 1994-2003, *The Economic Research Journal (in Chinese)*, 2005 (5), 31-39.
- Ma, J., B. Wang and X. Yang, (2010): The Impacts of the RMB Exchange Rate Changes to China’s Export Structure: An Empirical Analysis Based on SITC Classification, *Studies of International Finance (in Chinese)*, 2010 (12), 21-28.
- Marazzi, M., N. Sheets and R. Vigfusson, (2005): Exchange Rate Pass-through to U.S. Import Prices: Some New Evidence, Board of Governors of the Federal Reserve System International Finance Discussion Papers No.833.
- Marquez, J., (1990): Bilateral Trade Elasticities, *The Review of Economics and Statistics*, 72(1), 70-77.
- Oguro, Y., (2011): The Sensitivity of Export Quantities to Exchange Rates in the Context of Intra-Industry Trade, Global COE Hi-Stat Discussion Paper Series 167.
- Pesaran, M. H. and Yongcheol Shin, (2001): Bounds Testing Approaches to the Analysis of Level Relationships, *Journal of Applied Econometrics*, 16, 289-326.
- Qiang, Y., J. Wu and A. Chen, (2004): The impacts of the RMB Exchange Rate to China’s Foreign Trade, *World Economic Studies (in Chinese)*, 2004 (8), 4-9.
- Reinhart, C., (1995): Devaluation, Relative Prices, and International Trade: Evidence from Developing Countries, *Staff Papers-International Monetary Fund*, 42(2), 290-312.
- Rodrik, D., (2006): What’s So Special about China’s Exports? *China and World Economy*, 14

(5), 1-19.

Rose, A. K. and J. L. Yellen, (1989): Is There a J-Curve? *Journal of Monetary Economics*, 24, 53-68.

Schott, P. K., (2006): The Relative Sophistication of Chinese Exports, NBER Working Paper Series 12173.

Shu, C. and R. Yip, (2006), Impact of Exchange Rate Movements on the Mainland Economy, Hong Kong Monetary Authority China Economic Issue, Number 3/06.

Senhadji, A. S., and C. E. Montenegro, (1999): Time Series Analysis of Export Demand Equations: A Cross-Country Analysis, *IMF Staff Papers*, 46(3), 259-273.

Stopler, T. and M. Fuentes, (2007): GSDEER and Trade Elasticities, Working Paper to be Presented at the IIE, Bruegel and KIEP Workshop on “Target Current Account Outcomes”, <http://iiea.iie.com/publications/pb/pb07-4/stolper.pdf>.

Taplin, G.B., (1973): A Model of World Trade, In B. J. Ball (eds.), *The International Linkage of Economic Models*, 177-223. North Holland.

Thorbecke, W. and H. Zhang, (2008): The Effect of Exchange Rate Changes on China’s Labor-Intensive Manufacturing Exports, RIETI Discussion Paper Series, 08-E-038.

Thorbecke, W. and G. Smith, (2010): How Would an Appreciation of the Renminbi and Other East Asian Currencies Affect China’s Export, *Review of International Economics*, 18(1), 95-108.

Warner, D. and M. E. Kreinin, (1983): Determinants of International Trade Flows, *The Review of Economics and Statistics*, 65(1), 96-104.

Wilson, J. F. and W. E. Takacs, (1979): Differential Responses to Prices and Exchange Rate Influences in the Foreign Trade of Selected Industrial Countries, *The Review of Economics and Statistics*, 61(2), 267-279.

Xu, T., Y. Tu, (2006): The Estimation of China’s Trade Elasticity and Its Policy Implication, *The Journal of Quantitative and Technical Economics (in Chinese)*, 2006 (12), 14-22.

Yao, Z., F. Tian and Q. Su, (2010): The Income and Price Elasticity of China’s Exports, *The Journal of World Economy (in Chinese)*, 2010(4), 3-27.

Yuan, Z. and T. Shao, (2011): The Impacts of the RMB Exchange Rate Changes to the Profits of Different Industries in China, *Journal of Financial Research (in Chinese)*, 2001(4), 1-15.

Zeng, Z., Y. Zhang, (2007): The Structural Changes of China’s Exports and the RMB Real Exchange Rate, *The Journal of World Economy (in Chinese)*, 2007 (5), 16-24.

Annex1: The calculation of the variables in the econometric model

The General Customs of China reports the export value, export quantity index as well as export index at SITC one digit and two digit level every month since 2005. The EUROSTAT Comext database provides the import price index of EU 15 from Mexico and ASEAN countries at SITC one digit level.

Let V_i be China's export value of each SITC one digit level category and $i=5, 6, 7, 8$, represents SITC5 to SITC8 respectively. With the export value and export price index, it is quite easy to calculate the real value of export at each SITC one digit level category and let the real value of export be RV_i . Let $Export_i$ and $P_{ex,i}$ be the export quantity and export price index at SITC one digit level.

Since products under SITC5 and SITC7 are classified under capital and technology intensive products, the export quantity and export price index for capital and technology intensive products could be calculated as follows¹⁹:

Let $Export_h$ and $P_{ex,h}$ be the export quantity and price index for capital and technology intensive products.

$$Export_h = \frac{RV_5}{RV_5 + RV_7} Export_5 + \frac{RV_7}{RV_5 + RV_7} Export_7 \quad (A1)$$

$$P_{ex,h} = \frac{RV_5}{RV_5 + RV_7} P_{ex,5} + \frac{RV_7}{RV_5 + RV_7} P_{ex,7} \quad (A2)$$

The competitor's price which takes the EU 15 import from Mexico could also be calculated in the same way. Let $P_{MX,h}$ be the competitor's price index from Mexico.

¹⁹ In order to grasp the change of composition of products, the method taken in calculating the index is somehow a little different from the traditional ways.

$$P_{MX,h} = \frac{RV_5}{RV_5 + RV_7} P_{MX,5} + \frac{RV_7}{RV_5 + RV_7} P_{MX,7} \quad (A3)$$

Let $Export_l$, $P_{ex,l}$, and $P_{MX,l}$ be the export quantity, export price and competitor's price index for labor intensive products. All these three variables could be calculated in the same way as those variables for capital and technology intensive products.

The econometric model also used the combination of EU 15 import price from Mexico and ASEAN countries as another proxy for price of the competitors. The price index of the competitors could be calculated as follows:

Since the EU 15 import value and import price index are available at EUROSTAT Comext Database, it is quite easy to calculate the real value of capital and technology intensive products and labor intensive products. Let $RV_{MX,h}$ and $RV_{AEN,h}$ be the EU 15 real import value of capital and technology intensive products from Mexico and ASEAN countries. Let $P_{MX,h}$ and $P_{AEN,h}$ be EU 15 import price index from Mexico and ASEAN countries, which was calculated according to equation (A3), and $P_{comp,h}$ be the import price index from the combination of Mexico and ASEAN countries. $P_{comp,h}$ could be calculated as follows:

$$P_{comp,h} = \frac{RV_{MX,h}}{RV_{MX,h} + RV_{ASEAN,h}} P_{MX,h} + \frac{RV_{ASEAN,h}}{RV_{MX,h} + RV_{ASEAN,h}} P_{ASEAN,h} \quad (A4)$$

The competitor's price of labor intensive products $P_{comp,l}$ could also be calculated in the same way.

Annex 2: A brief introduction of AIC, SBC and HQ

AIC, SBC and HQ are all measures of relative goodness of fit of statistical models.

AIC, Akaike Information Criterion, is calculated as: $AIC = 2k + nLn \frac{RSS}{n}$, in which, k is the number of parameters, n is the number of observations.

SBC, Schwartz's Bayesian Information Criterion, is calculated as: $SBC = n \cdot Ln(\hat{\sigma}_e^2) + k \cdot Ln(n)$, in which $\hat{\sigma}_e^2$ is the error variance, k is the number of parameters and n is the number of observations.

HQ, Hannan Quinn Information Criterion, is calculated as: $HQ = nLn(\frac{RSS}{n}) + 2kLn(Ln(n))$.

When comparing the models, the model with smaller AIC, SBC or HQ is better.